DATA QUALITY SUMMARY REPORT FOR CLIMET OPTICAL PARTICLE COUNTER DATA COLLECTED BY SONOMA TECHNOLOGY, INC., DURING THE CALIFORNIA REGIONAL PM_{10}/$PM_{2.5}$ AIR QUALITY STUDY

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1. INTRODUCTION AND OBJECTIVES

The purpose of this Data Quality Summary Report is to provide data users with an understanding of the quality of Climet optical particle counter (OPC) data collected by Sonoma Technology, Inc. (STI) for the California Regional $PM_{10}/PM_{2.5}$ Air Quality Study (CRPAQS). **Table N-1** summarizes the operating sites and times for Climet OPC measurements during CRPAQS. This report provides summary information on data completeness, lower quantifiable limit (LQL), accuracy, and precision. The Climet OPC provided a medium-sized particle distribution via count information for 16 size-selective bins with a 5-minute time resolution. The 5-minute data were also averaged to 60-minute concentrations. Data completeness was calculated for all sites based on data delivered to ARB; the start date/time indicates the beginning of valid data, continuous until the stop date/time. Data validation suggested that all Climet OPC instruments performed similarly; thus Angiola Trailer was used as a representative site to calculate LQL, accuracy, and precision for all Climet OPC monitors operated by STI in the study.

Table N-1. Location and duration of Climet OPC measurements performed by STI during CRPAQS.

Site	Start Date/Time (PST)	Stop Date/Time (PST)
Angiola Trailer	3/30/00 14:40	2/8/01 20:55
Angiola 50-m Tower	8/18/00 13:00	2/12/01 15:00
Angiola 100-m Tower	8/18/00 15:40	2/16/01 12:10

Several other documents are available from which to obtain information about the CRPAQS field study and data processing. Sampling locations are described in Wittig et al. (2003). Quality control screening procedures are summarized by Hafner et al. (2003). Results of systems and performance audits and intercomparisons are provided by Bush et al. (2001). No data quality objectives (DQOs) were available for the Climet OPC.

2. DATA COMPLETENESS

Data completeness for Climet OPC is shown in **Table N-2**. Data capture quantifies the percentage of total records received versus the number expected during the “period of operation” defined by the start and stop dates/times in Table N-1; the start date/time is the first instance of valid data, and the period of operation is continuous until the stop date/time. The number of valid data points is divided by the number of captured data points to calculate the data recovery. Validity is defined for this calculation as any data point that has a quality control flag of V0 (valid) or V1 (valid but comprised wholly or partially of below-MDL data). Details of data validation are included in Hafner et al. (2003). For some sites, the data completeness information for several wavelengths (bins) was nearly identical; thus, the results for these calculations were combined. In these cases, the numbers of records and percents are per wavelength (bin).

Table N-2. Climet OPC data completeness values for the Angiola Trailer, Angiola 50-m Tower, and Angiola 100-m Tower.

Monitoring Site and Data Type	Bin	Total No. of Records	No. of Expected Records	Percent Capture[a]	No. of Valid Records	Percent Recovery[b]	No. of Suspect Records	No. of Invalid Records	No. of Missing Records
Angiola Trailer (5-minute)	1-16	90,796	90,796	100%	69,045	76%	4765	4943	12,043
Angiola Trailer (60-minute)	1	7567	7567	100%	5637	74%	468	535	927
Angiola Trailer (60-minute)	2-14	7567	7567	100%	5801	77%	304	535	927
Angiola Trailer (60-minute)	15-16	7567	7567	100%	5163	68%	942	535	927
Angiola 50-m Tower (5-minute)	1	52,375	52,375	100%	22,196	42%	13,698	9438	7043
Angiola 50-m Tower (5-minute)	2-16	52,375	52,375	100%	35,893	69%	1	9437	7044
Angiola 50-m Tower (60-minute)	1	4366	4366	100%	1868	48%	1150	933	415
Angiola 50-m Tower (60-minute)	2-14	4366	4366	100%	3018	69%	0	933	415

[a.] % capture = total number of records/expected records*100
[b.] % recovery = number of valid records/total numbers of records

Table N-2. Climet OPC data completeness values for the Angiola Trailer, Angiola 50-m Tower, and Angiola 100-m Tower.

Monitoring Site and Data Type	Bin	Total No. of Records	No. of Expected Records	Percent Capture[a]	No. of Valid Records	Percent Recovery[b]	No. of Suspect Records	No. of Invalid Records	No. of Missing Records
Angiola 50-m Tower (60-minute)	15-16	4366	4366	100%	2713	62%	305	933	415
Angiola 100-m Tower (5-minute)	1	51,289	51,289	100%	20,860	41%	14,730	5540	10,159
Angiola 100-m Tower (5-minute)	2-14	51,289	51,289	100%	33,237	65%	2353	5540	10,159
Angiola 100-m Tower (5-minute)	15-16	51,289	51,289	100%	32,092	63%	2353	6685	10,159
Angiola 100-m Tower (60-minute)	1	4275	4275	100%	1757	41%	1241	484	793
Angiola 100-m Tower (60-minute)	2-14	4275	4275	100%	2801	66%	197	484	793
Angiola 100-m Tower (60-minute)	15-16	4275	4275	100%	2359	55%	544	579	793

a. % capture = total number of records/expected records*100
b. % recovery = number of valid records/total numbers of records

All bins had a 100% data capture rate. Data recovery rates ranged from 41% (Angiola 100-m Tower 5-minute bin 1) to 77% (Angiola Trailer 60-minute bins 2-14).

3. LOWER QUANTIFIABLE LIMIT

The LQL is the lowest concentration in ambient air that can be measured when processing actual samples. Sources of variability that influence the monitored signal at low concentrations include instrument noise and atmospheric variability. As a measure of this variability, two times the standard deviation of selected 5-minute and 60-minute data were used to estimate the LQL. The selected data were taken during periods with concentrations close to the zero and relatively stable. This is a conservative estimate of the LQL because it includes the concentration variability of the ambient air. Twelve consecutive data values were used to compute the LQL with the 5-minute data and six data values with the 60-minute data; atmospheric variation generally becomes too great after six hours to calculate a reasonable LQL. Because only half the number of data values were used in the calculation (see "N" in Equation N-1), the 60-minute LQL is expected to be higher than the 5-minute LQL, despite the "smoothing" that occurs when averaging 5-minute to 60-minute values.

The LQL is calculated as shown in Equation N-1. **Tables N-3 and N-4** show the 5-minute and 60-minute LQL for selected size bins, as well as the specific data strings used to calculate the LQL.

$$\mathrm{LQL} \approx 2s = 2\sqrt{\frac{\sum (OPC - \overline{OPC})^2}{N-1}} \qquad \textbf{(N-1)}$$

where:

$\overline{OPC}$ = mean OPC count
N = number of measurements
σ = standard deviation

Table N-3. Time period used to calculate LQL, the LQL, and the corresponding mean concentration during the selected time period for 5-minute data.

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Bin	Start Date/Time Used in LQL Calculation (PST)	LQL Counts/cm^3	Mean Counts/cm^3
1	9/22/00 21:35	0.0431	0.5972
2	9/22/00 21:40	0.0158	0.1443
3	10/29/00 22:45	0.0063	0.0289
4	10/29/00 22:40	0.0065	0.0199
5	10/29/00 22:45	0.0053	0.0147
6	10/12/00 5:30	0.0022	0.0081

Table N-3. Time period used to calculate LQL, the LQL, and the corresponding mean concentration during the selected time period for 5-minute data.

Bin	Start Date/Time Used in LQL Calculation (PST)	LQL Counts/cm^3	Mean Counts/cm^3
7	10/12/00 5:20	0.001	0.0034
8	10/12/00 6:00	0.001	0.0017
9	10/12/00 6:00	0.0009	0.0024
10	10/12/00 6:00	0.0015	0.0024
11	1/24/01 12:40	0.0007	0.0006
12	12/19/00 3:10	0.0005	0.0003
13	1/17/01 5:10	0.0003	0.0001
14	1/17/01 4:30	0.0002	0.0001
15	1/25/2001 02:00	0.0003	0.0001
16	8/30/2000 03:50	0.0002	0.0001

Table N-4. Time period used to calculate LQL, the LQL, and the corresponding mean concentration during the selected time period for 60-minute data.

Bin	Start Date/Time Used in LQL Calculation (PST)	LQL Counts/cm^3	Mean Counts/cm^3
1	5/10/00 22:00	0.258	3.4154
2	5/10/00 21:00	0.028	0.9248
3	1/10/01 23:00	0.0183	0.1621
4	1/24/01 15:00	0.0191	0.0706
5	10/30/00 2:00	0.015	0.0443
6	10/30/00 2:00	0.0058	0.0147
7	10/30/00 2:00	0.0024	0.0061
8	1/25/01 3:00	0.0021	0.0023
9	1/25/01 3:00	0.0015	0.0028
10	1/17/01 2:00	0.0015	0.0041
11	10/11/00 1:00	0.0006	0.0102
12	1/17/01 2:00	0.001	0.0009
13	1/24/01 6:00	0.0004	0.0013
14	1/24/01 6:00	0.0004	0.0005
15	1/10/01 23:00	0.0002	0.0002
16	5/25/00 23:00	0.0001	0.0006

4. ACCURACY

The calibration of the OPCs consisted of a flow check performed at the inlet located on the sampling trailer's roof, flow checks performed on individual instruments, dynamic zeroes, and polystyrene latex (PSL) checks. Quantitative calibration data were not available for this instrument, nor were flow checks performed regularly enough to calculate a meaningful accuracy of the flow. Therefore, accuracy calculations for this instrument are beyond the scope of this report.

Qualitatively, the PSL checks provide an indication of how well the OPCs separated particles of varying sizes. For these checks, moderate concentrations of PSL spheres of known diameter were nebulized and injected in a diluted sample stream. Five spheres of different-sized diameters—4.6 µm, 1.4 µm, 0.89 µm, 0.58 µm, and 0.23 µm—were used. The largest four spheres (0.58-4.6 µm) were measured by the Climet OPC; the smaller four spheres (0.23-1.4 µm) were measured by the PMS Lasair OPC, and the smallest spheres (0.23 µm) were also measured by the Scanning Mobility Particle Sizer (SMPS). The operator verified that the majority of the spheres fell into the correct size bin of a given instrument by recording the counts in the relevant bins and/or by compiling the computer-generated printouts of the bin counts. All the documented PSL checks on the Lasair OPC, ground-level Climet OPC, and 100-m Climet OPC passed. The few failed PSL checks on the 50-m Climet OPC were attributed to a misaligned laser diode.

5. PRECISION

Precision can be measured for the OPC by evaluating the variance of particle counts during a period of low variability when atmospheric influence on variability is assumed to be minimal. Five-minute and 60-minute data were selected during periods of low variability but when concentrations were well above the LQL. The precision was then evaluated by calculating the coefficient of variation (CV) during the period of low variability, as shown in Equation N-2.

$$\mathrm{Pr}\,ecision \approx CV = \frac{s_{measured}}{\left[\overline{OPC}\right]_{measured}} \times 100\% \qquad \textbf{(N-2)}$$

where:

$$s_{measured} = \sqrt{\frac{\sum\left(\left[OPC\right]_{measured} - \left[\overline{OPC}\right]_{measured}\right)^2}{N-1}}$$

All the particle count values in Equation N-2 refer to the counts during the selected time period. **Tables N-5 and N-6** show the precision of 5-minute and 60-minute data for each bin calculated at the representative site, Angiola.

Table N-5. Precision, the number of data points, time period and mean of the data used to calculate the precision of 5-minute OPC data at the representative site Angiola.

Bin	No. of Data Points Used	Time Period (PST)	Mean Counts/cm^3	Precision (%)
1	12	1/31/01 21:15	291.4283	1.3
2	13	10/31/00 6:20	26.92	1.3
3	12	11/21/00 17:25	32.9778	1.1
4	20	11/21/00 18:05	24.9855	1.4
5	13	2/1/01 16:10	6.8427	1.4
6	12	5/31/00 2:00	1.2509	1.4
7	12	8/30/00 20:05	0.3719	2.6
8	14	1/3/01 13:50	0.6079	2.4
9	14	6/24/00 2:00	0.5367	2.4
10	15	5/31/00 2:15	0.1891	3.8
11	12	5/23/00 20:00	0.0669	2.6
12	12	11/5/00 1:55	0.0672	4.2
13	13	9/12/00 23:45	0.1363	3.8
14	12	9/12/00 23:40	0.0893	5.0
15	12	9/6/00 2:00	0.0116	5.9
16	13	8/11/00 13:50	0.0014	6.2

Table N-6. Precision, the number of data points, time period and mean of the data used to calculate the precision of 60-minute OPC data at the representative site Angiola.

Bin	No. of Data Points Used	Time Period (PST)	Mean Counts/cm^3	Precision (%)
1	6	11/16/00 20:00	181.73	3.8
2	7	5/24/00 17:00	7.319	5.3
3	6	5/16/00 23:00	0.477	5.0
4	6	5/16/00 23:00	0.4593	2.9
5	6	5/16/00 23:00	0.5926	3.0
6	6	5/16/00 23:00	0.3064	4.3
7	6	5/16/00 23:00	0.1252	4.7
8	6	1/18/01 14:00	0.0357	4.8
9	6	10/17/00 11:00	0.2833	6.0
10	7	7/5/00 8:00	0.129	9.2
11	9	7/12/00 17:00	0.0846	7.7
12	9	7/12/00 17:00	0.0677	7.3
13	6	2/7/01 0:00	0.0101	6.4
14	6	2/7/01 0:00	0.0054	7.4
15	6	9/16/00 19:00	0.025	4.5
16	8	6/10/00 14:00	0.0008	4.2

6. REFERENCES

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